CLAIMS

1. An active noise controller comprising:

a mode selector for selecting between normal mode and measurement mode;

a frequency detector for detecting a frequency of vibrational noise generated from a vibrational noise source based on the normal mode selected by the mode selector;

a pseudo-vibrational noise generator for outputting a signal in a predetermined frequency range corresponding to the frequency of the vibrational noise generated from the vibrational noise source, based on the measurement mode selected by the mode selector;

a first switch for selecting between the output signal of the pseudo-vibrational noise generator and an output signal of the frequency detector, and outputting the output signal selected;

a reference cosine wave generator and a reference sine wave generator for receiving the output signal of the first switch;

a first adaptive notch filter for outputting a first control signal based on the reference cosine wave signal outputted from the reference cosine wave generator in order to cancel the vibrational noise generated, based on the vibrational noise from the vibrational noise source;

a second adaptive notch filter for outputting a second control signal based on the reference sine wave signal outputted from the reference sine wave generator;

a first adder for receiving the first control signal and the second control signal;

a second switch for receiving a signal outputted from the first adder;

a third switch for receiving one of the reference cosine wave signal and the reference sine wave signal;

a vibrational noise canceller for canceling the vibrational noise generated, the vibrational noise canceller receiving an output of the second switch and an output of the third switch;

an error signal detector for outputting an error signal resulting from interference between the vibrational noise generated and a noise-canceling sound outputted from the vibrational noise canceller;

a fourth switch for receiving the output of the first adder;

a second adder for receiving an output of the fourth switch and the output of the error signal detector;

a fifth switch for receiving the reference cosine wave signal;

a sixth switch for receiving the reference sine wave signal;

a first filter coefficient updater for calculating a filter coefficient of the first adaptive notch filter based on an output signal of the second adder and an output signal of the fifth switch so as to minimize the output signal of the second adder, and for updating the filter coefficient sequentially;

a second filter coefficient updater for calculating a filter coefficient of the second adaptive notch filter based on the output

signal of the second adder and an output signal of the sixth switch so as to minimize the output signal of the second adder, and for updating the filter coefficient sequentially;

a correction value calculator for receiving the filter coefficients of the first and second filter coefficient updaters, the correction value calculator being able to calculate at least a phase characteristic value out of a gain characteristic value and the phase characteristic value of signal transmission characteristics from the vibrational noise canceller to the error signal detector, corresponding to a frequency of one of the reference cosine wave signal and the reference sine wave signal, and also being able to calculate a cosine correction value and a sine correction value; and

a corrector for correcting the reference cosine wave signal and the reference sine wave signal by using the cosine correction value and the sine correction value, respectively, and outputting a corrected cosine wave signal and a corrected sine wave signal to the fifth switch and the sixth switch, respectively, wherein

the corrector comprises:

a memory for storing the cosine correction value and the sine correction value;

a first multiplier for forming a product of the cosine correction value and the reference cosine wave signal;

a second multiplier for forming a product of the sine correction value and the reference sine wave signal;

a third multiplier for forming a product of the cosine correction value and the reference sine wave signal;

a fourth multiplier for forming a product of the sine correction value and the reference cosine wave signal;

a third adder for receiving an output signal of the first multiplier and an output signal of the second multiplier separately, and outputting the corrected cosine wave signal; and

a fourth adder for receiving an output of the third multiplier and an output of the fourth multiplier separately, and outputting the corrected sine wave signal.

2. The active noise controller of claim 1, wherein in the measurement mode,

the first switch inputs the output signal of the pseudo-vibrational noise generator to the reference cosine wave generator and the reference sine wave generator;

the second switch prevents the output signal of the first adder from being inputted to the vibrational noise canceller;

the third switch inputs one of the reference cosine wave signal and the reference sine wave signal to the vibrational noise canceller;

the fourth switch inputs the output signal of the first adder to the second adder;

the fifth switch prevents the corrected cosine wave signal of the third adder from being inputted to the first filter coefficient

updater, and inputs the reference cosine wave signal to the first filter coefficient updater;

the sixth switch prevents the corrected sine wave signal of the fourth adder from being inputted to the second filter coefficient updater, and inputs the reference sine wave signal to the second filter coefficient updater;

the correction value calculator calculates the cosine correction value and the sine correction value by using the filter coefficients of the first and second filter coefficient updaters for each output signal having the predetermined frequency outputted from the pseudo-vibrational noise generator; and

the memory stores the cosine correction value and sine correction value corresponding to the each output signal having the predetermined frequency.

3. The active noise controller of claim 1, wherein in the normal mode,

the first switch inputs the output signal of the frequency detector to the reference cosine wave generator and the reference sine wave generator;

the second switch inputs the output signal of the first adder to the vibrational noise canceller;

the third switch prevents one of the reference cosine wave signal and the reference sine wave signal from being inputted to the vibrational noise canceller;

the fourth switch prevents the output signal of the first adder from being inputted to the second adder;

the fifth switch inputs the corrected cosine wave signal outputted from the third adder to the first filter coefficient updater, and prevents the reference cosine wave signal from being inputted to the first filter coefficient updater;

the sixth switch inputs the corrected sine wave signal outputted from the fourth adder to the second filter coefficient updater, and prevents the reference sine wave signal from being inputted to the second filter number updater; and

the vibrational noise canceller cancels the vibrational noise generated so as to minimize the signal of the second adder by using the corrected cosine wave signal, the corrected sine wave signal, and the output signal of the second adder,

the corrected cosine wave signal and the corrected sine wave signal being respectively derived from the cosine correction value and sine correction value corresponding to each output signal having the predetermined frequency, which is calculated when the measurement mode is selected by the mode selector and stored in the memory.

4. The active noise controller of claim 1, wherein

the mode selector is incorporated in an in-car apparatus and constructed so as to be able to select between the normal mode and the measurement mode by a predetermined operation.

5. The active noise controller of claim 4, wherein

the in-car apparatus is one of an audio system and a navigation system.

6. The active noise controller of claim 4, wherein

the mode selector is at least one of a touch panel having an operation input portion and a speech recognizer having a mechanical switch and a microphone.

7. The active noise controller of claim 1 further comprising:

a second memory for storing the gain characteristic value and phase characteristic value calculated by the correction value calculator; and

a comparator for at least comparing a phase characteristic value calculated first with a phase characteristic value calculated later by the correction value calculator and determining whether difference between the phase characteristic values is within a predetermined value, out of a gain characteristic value and the phase characteristic value calculated first and a gain characteristic value and the phase characteristic value calculated later.

8. The active noise controller of claim 7, wherein

the comparator issues a warning when the difference between the phase characteristic values exceeds the predetermined value.

9. The active noise controller of claim 7, wherein

when the comparator determines that the difference between the phase characteristic values exceeds the predetermined value,

the correction value calculator again calculates a cosine correction value and a sine correction value by using the filter coefficients outputted from the first and second filter coefficient updaters, respectively, and

the memory stores the cosine correction value and the sine correction value.

10. The active noise controller of claim 2, wherein

the mode selector is constructed to select the measurement mode when an engine is in a stopped state.

11. The active noise controller of claim 1 further comprising:

a plurality of vibrational noise cancellers; and

a selector for selecting at least one of the plurality of vibrational noise cancellers.

12. The active noise controller of claim 1 further comprising:

a plurality of error signal detectors; and

a selector for selecting at least one of the plurality of error signal detectors.

13. The active noise controller of claim 11, wherein

at least one of the plurality of vibrational noise cancellers is selected for each output signal having the predetermined frequency, which is outputted from the pseudo-vibrational noise generator in the measurement mode.

14. The active noise controller of claim 12, wherein

at least one of the plurality of error signal detectors is selected for each output signal having the predetermined frequency, which is outputted from the pseudo-vibrational noise generator in the measurement mode.

15. The active noise controller of any one of claims 11 to 14 further comprising:

a third memory for storing the gain characteristic value and the phase characteristic value, which are calculated by the correction value calculator, of the signal transmission characteristics from a selected vibrational noise canceller to a selected error signal detector, the third memory storing the gain characteristic value and the phase characteristic value for one of each of the plurality of vibrational noise cancellers and each of the plurality of error signal detector and;

a second comparator for comparing the gain characteristic and/or the phase characteristic stored in the third memory for one of each of the plurality of vibrational noise cancellers and each of the plurality of error signal detector.

16. The active noise controller of claim 15, wherein

the second comparator compares at least one of between the gain characteristics and between the phase characteristics;

the correction value calculator calculates the cosine correction value and the sine correction value based on the gain characteristic value and phase characteristic value of the signal transmission characteristics which are selected from comparison results by a predetermined standard; and

the memory stores calculation results.

17. The active noise controller of claim 15, wherein

the second comparator compares between the gain characteristics and/or between the phase characteristics for each predetermined frequency and selects best signal transmission characteristics by a predetermined standard;

the correction value calculator calculates the cosine correction value and the sine correction value based on the gain characteristic value and phase characteristic value of the signal transmission characteristics selected; and

the memory stores the cosine correction value and the sine correction value.

18. The active noise controller of claim 1 further comprising:

a first corrector for correcting one of the reference sine wave signal outputted from the reference sine wave generator and

the reference cosine wave signal outputted from the reference cosine wave generator, wherein

in the measurement mode, one of the reference sine wave signal and the reference cosine wave signal is corrected by the first corrector and inputted to the vibrational noise canceller by the third switch.

19. The active noise controller of claim 18, wherein

in the measurement mode, the gain characteristic value of the signal transmission characteristics from the vibrational noise canceller to the error signal detector is calculated based on the filter coefficients determined in a manner described in claim 2 and a first correction value applied to the first corrector.

20. The active noise controller of claim 1 further comprising

a seventh switch for receiving the reference cosine wave signal outputted from the reference cosine wave generator and the first control signal outputted based on the first adaptive notch filter;

an eighth switch for receiving the reference sine wave signal outputted from the reference sine wave generator and the second control signal outputted based on the second adaptive notch filter;

a second corrector for correcting the first control signal and making the seventh switch input a corrected signal to the first adder when the measurement mode is selected; and

a third corrector for correcting the second control signal and making the eighth switch input a corrected signal to the first adder when the measurement mode is selected.

21. The active noise controller of claim 20, wherein

in the measurement mode, the gain characteristic value of the signal transmission characteristics from the vibrational noise canceller to the error signal detector is calculated based on the filter coefficients determined in claim 2, a second correction value applied to the second corrector, and a third correction value applied to the third corrector.

22. The active noise controller of claim 1 further comprising

a first corrector for correcting one of the reference sine wave signal outputted from the reference sine wave generator and the reference cosine wave signal outputted from the reference cosine wave generator;

a seventh switch for receiving the first control signal;

an eighth switch for receiving the second control signal;

a second corrector for correcting the first control signal and making the seventh switch input a corrected signal to the first adder when the measurement mode is selected; and

a third corrector for correcting the second control signal and making the eighth switch input a corrected signal to the first adder when the measurement mode is selected.

23. The active noise controller of claim 22, wherein

in the measurement mode, the gain characteristic value of the signal transmission characteristics from the vibrational noise canceller to the error signal detector is calculated based on the filter coefficients determined in a manner descried in claim 2, a first correction value applied to the first corrector, a second correction value applied to the second corrector, and a third correction value applied to the third corrector.

24. The active noise controller of claim 1, wherein

in the normal mode, a fourth corrector corrects the output signal of the first adder based on the gain characteristic value, which is calculated in a manner described in claim 23, of the signal transmission characteristics from the vibrational noise canceller to the error signal detector.

25. The active noise controller of claim 1, wherein

in the normal mode, a predetermined parameter applied to the the first filter coefficient updater and the second filter coefficient updater is corrected based on the gain characteristic value, which is calculated in a manner described in claim 23, of the signal transmission characteristics from the vibrational noise canceller to the error signal detector.